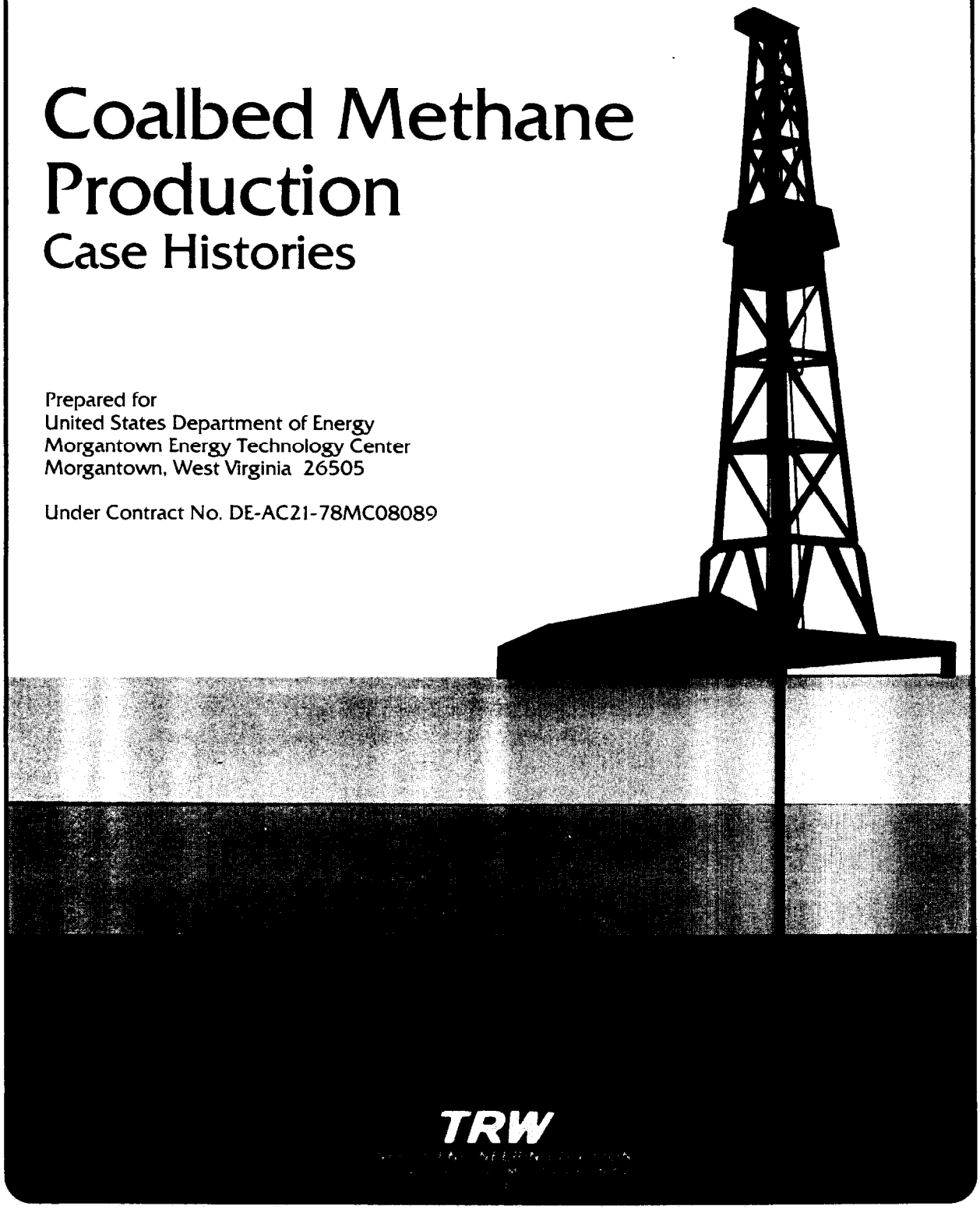
Coalbed Methane Production
Case Histories



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TRW

COALBED METHANE PRODUCTION

CASE HISTORIES

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NOTICE

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF TABLES

ABSTRACT

The production of methane gas from coal and coal-bearing rocks is one of the prime objectives of the Department of Energy's Methane Recovery from Coalbeds Project. This report contains brief description of wells that are presently producing gas from coal or coal-bearing rocks. Data from three gob gas production areas in Illinois, an in-mine horizontal borehole degasification, and eleven vertical boreholes are presented. Production charts and electric logs of the producing zones are included for some of the wells. Additional information on dry gas production from the San Juan Basin, Colorado/New Mexico and the Greater Green River Coal Region, Colorado/Wyoming is also included.

ACKNOWLEDGMENTS

This report is a compilation of data and information from many persons and sources. TRW acknowledges the cooperation of the Department of Energy/Morgantown Energy Technology Center for whom the report was prepared. The technical contributions of C. Rightmire, J. McCord, J. Kirr and R. Wimer were helpful in compiling, writing and editing. The cooperation of the Dugan Production Company of Farmington, New Mexico in providing data and logs from their wells also is greatly appreciated.

1. SUMMARY

This report presents brief descriptions of various efforts to produce the coalbed methane resource. These efforts include three instances of gob gas production from abandoned mines, one in-mine horizontal borehole degasification research program, and eleven instances of vertical borehole coalbed methane production. Two basin reviews were conducted to determine areas where dry gas production could be from coalbeds.

The three gob gas production examples are all in the Illinois Basin. In each case, relatively inexpensive vertical boreholes were drilled into abandoned mine workings or existing vent holes were utilized. Sustained production from these wells varies from 60 Mcfd to 180 Mcfd. Produced gas is injected directly into pipeline systems.

The in-mine horizontal borehole degasification research project of the Department of Energy (DOE) is part of the Methane Recovery from Coalbeds Program (MRCP). This research project, conducted in cooperation with the Occidental Research Corporation is designed to develop a technique to recover methane from multiple horizontal in-mine boreholes. In addition, multiple uses of the produced methane are being investigated. These include supplying mine site energy requirements, LNG production, and commercial pipeline injection. Potential side benefits of this project may include a safer mining environment and increased mining speeds due to the degasification in advance of mining. A portion of the gas production will be utilized in the thermal dryers at a nearby coal processing plant in early 1981.

The eleven examples of vertical borehole coalbed methane production include two efforts designed primarily to degasify coal in advance of mining, two DOE MRCP projects to exploit this resource from unmined coal, and seven commercial wells completed in coal-bearing formations. The mining related degasification programs are both located in the Warrior Basin in Alabama and are draining methane from the very gassy Mary Lee coal seam (up to 550 cu ft/ton). One of the projects in cooperation with the DOE MRCP is to improve mine safety with a potential for increased mining rates.

Methane presently produced from these projects is being vented to the atmosphere. The two DOE MRCP representative vertical well projects to obtain coalbed methane are located in Greene County, Pennsylvania and in the Book Cliffs coal field in Utah. These projects, in addition to testing the production potential for this resource, help identify technical problems which must be overcome before there can be widespread commercial coalbed methane production. Six of the commercial wells described in this report are producing from the coal-bearing Fruitland Formation in the San Juan Basin. One of these wells, the Phillips No. 6-17, was completed open-hole over an interval containing several thick coalbeds. The other five wells were completed directly in coalbeds or under the thick coalbed at the base of the Fruitland Formation. Daily gas production from these wells ranges up to approximately 500 Mcf (Dugan Production ABO No. 1 Well). The seventh commercial well described in this report is the Exxon Vega Unit No. 2 which is producing from the Mesaverde Formation in the Piceance Basin, Colorado. Initial testing of this well indicated a production of 440 Mcfd.

The two basin reviews were aimed at identifying gas fields which produce dry gas from coal-bearing formations in the San Juan Basin of New Mexico and Colorado, and the Greater Green River Coal Region of Colorado and Wyoming. It is possible that a detailed review of drilling records, completion and production records, and gas analyses in these identified gas fields may establish a direct relationship to coalbed methane. This avenue of investigation, in conjunction with direct sampling and testing of coalbeds in these areas, is recommended.

2. INTRODUCTION

During the natural process of coal formation, methane, the principal constituent of natural gas, is generated and trapped in the coal seam as well as in the adjacent rock area. All coal deposits contain methane. The concentration of methane varies from seam to seam, and within the seam. Recent estimates of the methane reserves in coalbeds are reported to approximate 700 trillion cubic feet. Given current and conservatively projected economic and technological factors, the recovery of an estimated 300 trillion cubic feet of the resource appears feasible. Based on present consumption rate, this is equal to a 10- to 12-year supply of the commodity.

In order to curb the waste of methane contained in coalbeds, and to provide for its recovery and utilization, the Department of Energy (DOE) has initiated the Methane Recovery from Coal Project (MRCP). Major project objectives include:

- Location and characterization of methane resources
- Development of improved, cost-effective methane recovery and utilization technology
- Development of methane conservation techniques and systems
- Development of methane recovery prediction and projection techniques (models for well productivity)
- Development of field tests for pilot systems
- Investigation of legal and institutional constraints
- Transfer of applicable technologies to private industry.

This report is a compilation of case histories for various coalbed methane field projects and resource characterization studies. In addition, several commercial ventures which produce coalbed methane are described.

3. CASE HISTORIES

The following brief case histories summarize the known efforts to produce coalbed methane. It is possible that these efforts are only the tip of the iceberg.

3.1 GOB GAS PRODUCTION

3.1.1 WOERA - Farris Well

WOERA's Farris Well in Illinois has been producing gas in the Illinois Basin since 1954. The well is located in Saline County, Illinois on the site of the abandoned Dering Mine. The gas is being produced from a mined out area. Daily production averages 180 Mcf from the hole, and the cumulative production is approximately 88 MMcf. The gas produced from this well is sold to United Cities Gas Corporation for direct use in its system

3.1.2 RE Company - Adam No. 1 Well

The RE Company, Adams No. 1 Well, Saline County, Illinois, is producing methane from the Southern Counties' No. 1 Mine abandoned in 1929. This well produces an average of 155 Mcf, which is limited by demand on a low pressure system, and has produced 62 MMcf to date. Gas from the Adams No. 1 Well is introduced directly into a local distribution system.

3.1.3 Petro-Search

Petro-Search is producing gas from the abandoned Ogera No. 8 Mine, Saline County, Illinois, at an average production rate of 60 Mcf at 1 oz. pressure. Approximately 100 MMcf has been produced from these workings.

3.2 HORIZONTAL IN-MINE BOREHOLE PRODUCTION

3.2.1 Occidental Research Corporation - Island Creek

Occidental Research Corporation in cooperation with the DOE MRCP is conducting a project at the Island Creek Coal Company Virginia Pocahontas No. 5 Mine to develop a technique for methane recovery using multiple horizontal boreholes. The mine is located in Buchanan County in the western part of Virginia. Twelve boreholes have been drilled by Occidental

for methane drainage. The holes intersected either the Pocahontas No. 3 coal seam or the Pocahontas No. 3 and No. 4 coal seams. Daily production from the twelve holes ranges from 10 Mcfd to 434 Mcfd with the holes ranging in length from 385 to 1,720 feet. Cumulative production from March 1978 through November 1980 was approximately 350 MMcf (Figure 1). Four options are being analyzed for the use of the methane produced: an onsite coal dryer, a mine fan, LNG unit, or commercial pipeline use. The coal dryer utilization will be initiated in early 1981.

3.3 VERTICAL BOREHOLE PRODUCTION

3.3.1 U.S. Steel - Oak Grove

U.S. Steel Corporation in cooperation with the DOE MRCP has drilled 28 vertical boreholes at their Oak Grove Mine, Jefferson County, Alabama, in the Warrior Basin. The methane drained by this project is from the 5.2 foot Mary Lee coal seam which is approximately 1,100 feet deep. The specific gas content averages 435 cu ft/ton. Twenty-three of the boreholes, laid out in a 3 by 5 grid pattern with a 21.5 acre spacing, are placed approximately five years ahead of active mining. As of August 1980, these wells had been drilled and were planned to be in production by October 1980. Cumulative daily production from these 23 wells is projected to be approximately 1.7 MMcfd, with an average per well production of approximately 70 Mcfd. The entire well pattern currently produces about 300 barrels of water a day.

United States Steel Corporation is proceeding with plans to commercially pipeline the gas being produced as a result of this prototype borehole degasification program.

Methane content of the produced gas averages in excess of 96 percent with heating value greater than 970 Btu/cf. Combined daily gas production as of August 1980 from 17 producing wells was approximately 1.0 MMcfd. Cumulative production from these 17 wells through August 1980 is estimated to be 750 MMcf (Figure 2).

3.3.2 Jim Walters Resource Company - No. 4 Mine

The Jim Walters Resource Company has undertaken a coalbed methane drainage program in advance of mining at their No. 4 mine in Tuscaloosa

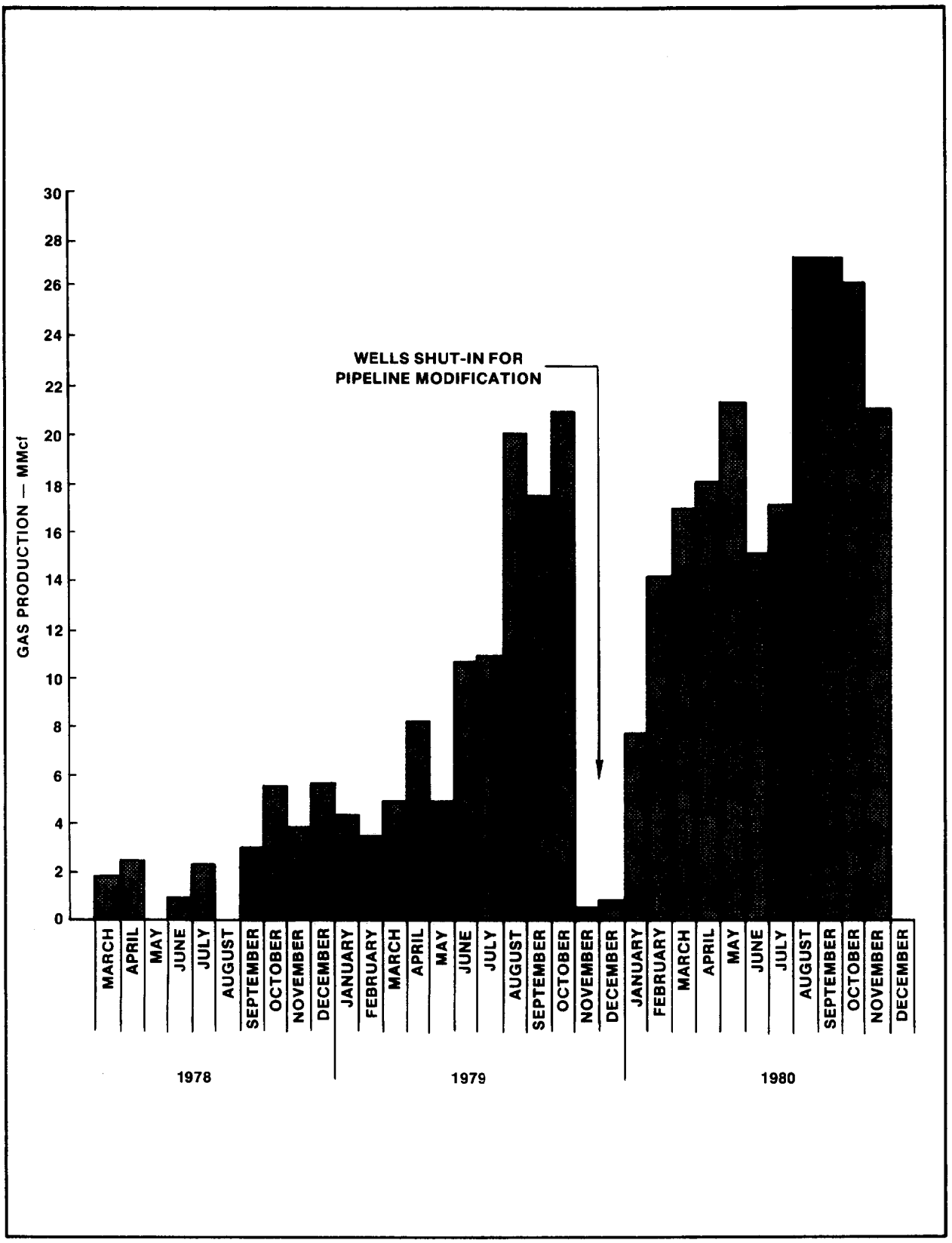

Figure 1. Monthly Gas Production, ORC-Island Creek In-Mine Horizontal Boreholes, March 1978 through November 1980

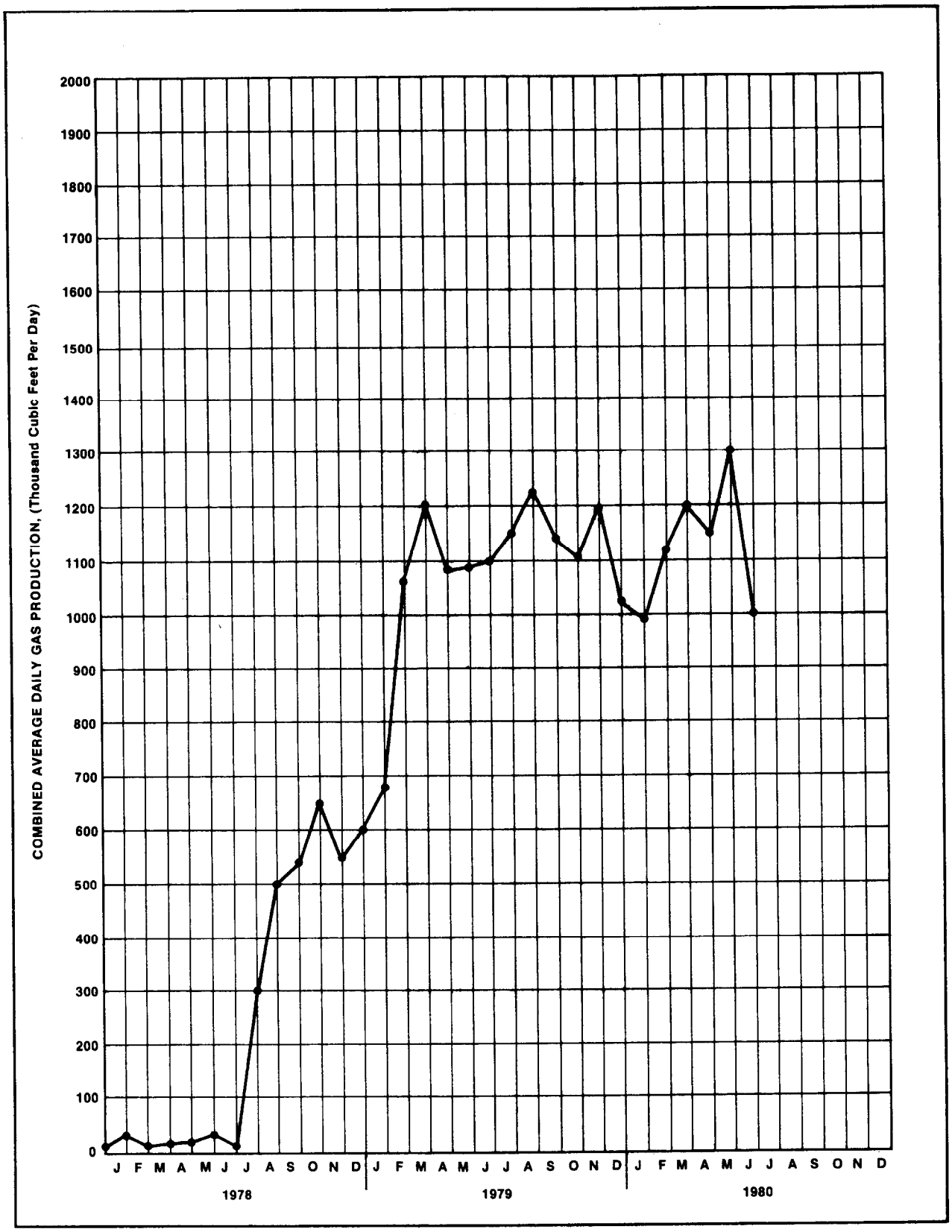

Figure 2. U.S. Steel-Oak Grove, Total Gas Production from 17 Producing Wells through August 1980

County, Alabama. The primary seam in this mine is the Mary Lee, which ranges up to 5.5 feet in thickness. Overburden ranges from 1,500 to 2,000 feet. Methane content of the Mary Lee coal in this area is approximately 550 cu ft./ton.

The first of five wells, spaced 2,000 feet apart, was drilled in September of 1978 and by June of 1979 all wells had been completed and stimulated at low injection rates with foam and sand. In spite of removal of approximately 1,500 barrels per day of water, post-stimulation gas flow remained low, averaging about 30 Mcfd for all wells until August of 1980. At that time well No. 1 was mined through and dewatering was effected through the mine face. Very high flows--2.5 MMcfd from one well for a few days--resulted from dewatering and erratic flows were recorded through October, 1980. During November and December, 1980 water production from the remaining four wells began to decline and gas flow stabilized at about 800 Mcfd. Figure 3 shows the gas and water flow history for these four wells during 1980.

To date, all gas production has been vented to the atmosphere. The Jim Walters Resource Company is presently exploring several gas utilization plans. In addition to this vertical borehole degasification effort, the Jim Walters Resource Company is initiating an in-mine horizontal borehole degasification program.

3.3.3 Waynesburg College - Greene County, Pennsylvania

With support from DOE/MRCP and the Appalachian Regional Commission, Waynesburg College cored, stimulated, and is in the process of dewatering and testing a vertical well in central Greene County, Pennsylvania. The well was drilled to a total depth of 1,450 feet and encountered about 35 feet of coal in nine beds. These coals contained between 70 and 195 cu ft/ton total gas. Three intervals were perforated and stimulated using a nitrogen foam treatment. Dewatering is currently in progress with gas production in excess of 30 Mcfd. The gas has been accepted for injection into a distribution pipeline. The College plans to utilize the gas to offset winter heating costs.

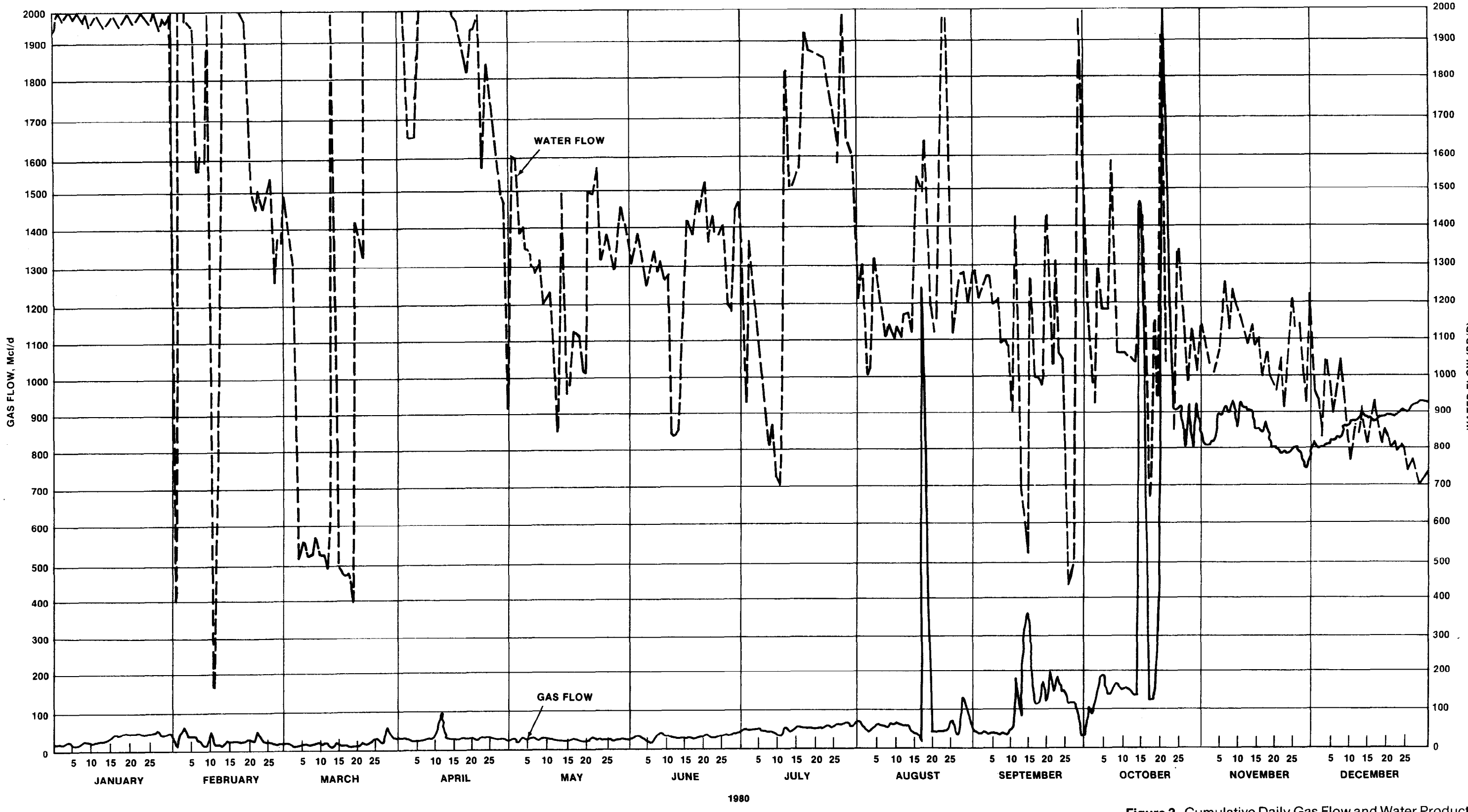

Figure 3. Cumulative Daily Gas Flow and Water Production Rates from Four Degasification Wells, Jim Walters Resource Company No. 4 Mine, Tuscaloosa County, Alabama

3.3.4 Mountain Fuel Supply Company - Book Cliffs Coal Field

In conjunction with DOE/MRCP Mountain Fuel has drilled, tested, and completed two vertical wells in the Whitmore Park area of the Book Cliffs region of northeastern Utah. Coals of the Sunnyside and Gilson seams (12 and 14 feet thick, respectively) are encountered at depths between 3,000 and 3,177 feet. Methane content in these coal seams ranges from 220 up to approximately 440 cu ft/ton. In September 1980, Well No. 2 was fractured using a nitrogen foam hydraulic stimulation treatment. Pre-stimulation gas production was very low, averaging between 500 to 700 cfd. Pre-stimulation water production was approximately 1.5 gpm. Initial gas production after stimulation ranged from 15 to 22 Mcfd. Increased water production rates of approximately 5 gpm were also observed.

Currently Well No. 1 is being used as a monitoring hole to help analyze the reservoir response to the stimulation activities and production testing in Well No. 2. However, at some point in the future, it is planned that the lower portion of Well No. 1 will be cemented off and the two Sunnyside coalbeds higher in the well will be perforated and fractured. Production testing will then be initiated in this well.

3.3.5 Phillips Petroleum Company No. 6-17 Well

The Phillips Petroleum Company Well No. 6-17, located in T31N, R7W, San Juan County, New Mexico, was completed in the coal-bearing Fruitland Formation and has produced significant quantities of dry gas since August 1953, with steadily increasing annual production (Figure 4). Daily gas production is approximately 150 Mcf. This well was completed open-hole from 3,054 to 3,240 feet. Logs from other wells in this area indicate that this production interval contains several thick coal seams.

3.3.6 Palmer Oil and Gas - State No. 2 Well

Methane is produced from the Palmer Oil and Gas State No. 2 Well in the San Juan Basin, New Mexico. The methane production zones are located in the Fruitland and the Pictured Cliffs Formations. The depth of the Fruitland Formation production zone is found between 3,174 and 3,279 feet. The depth of the Pictured Cliffs Formation production zone is located between 3,354 and 3,378 feet. Production intervals generally correspond to coalbeds or directly underlie coalbeds (Figure 5). During April 1979 the

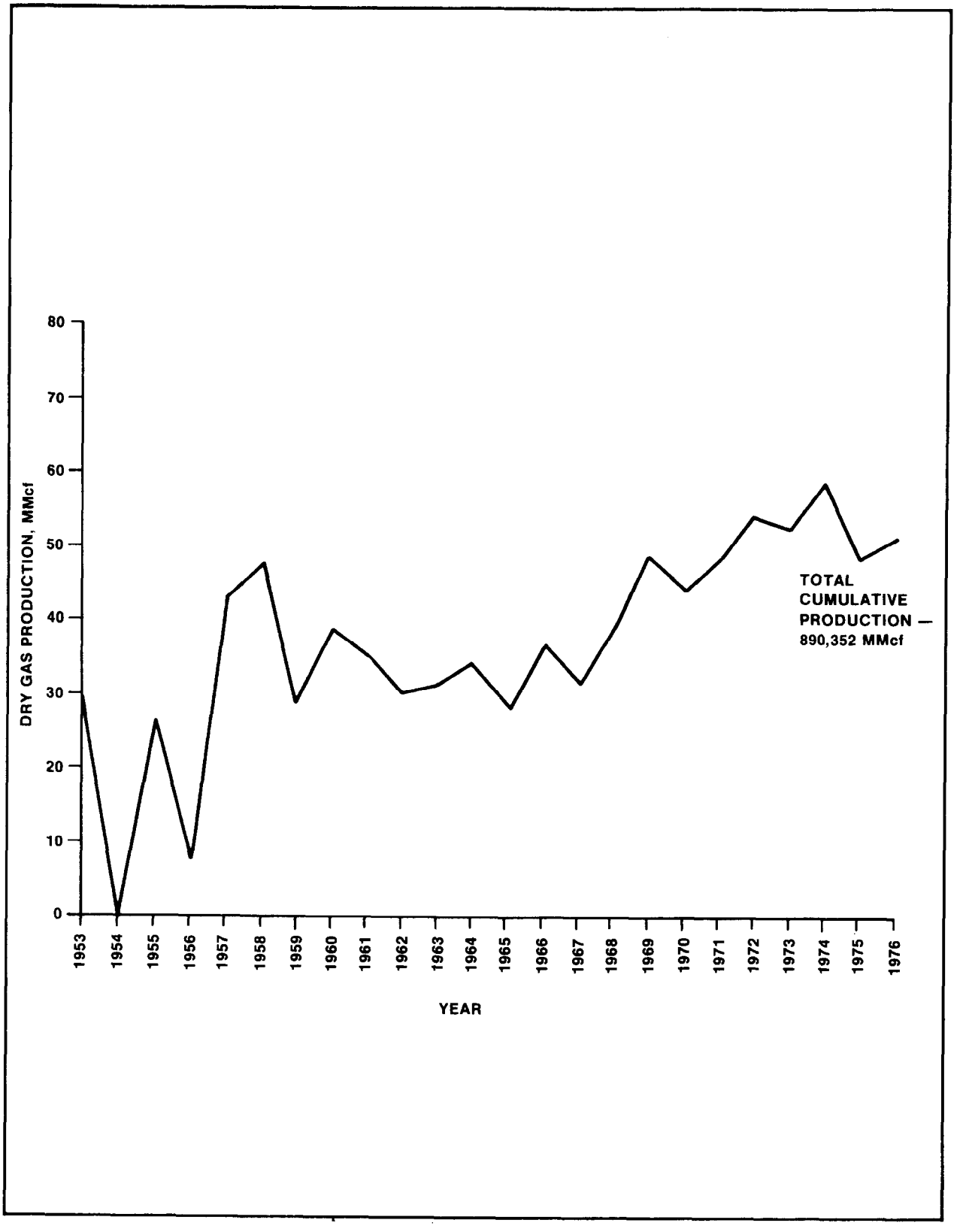

Figure 4. Annual Production Curve, Phillips No. 6-17 San Juan 32-7 Unit, August 1953 through 1976 (Four Corners Geological Society Oil and Gas Field Guidebook, 1978)

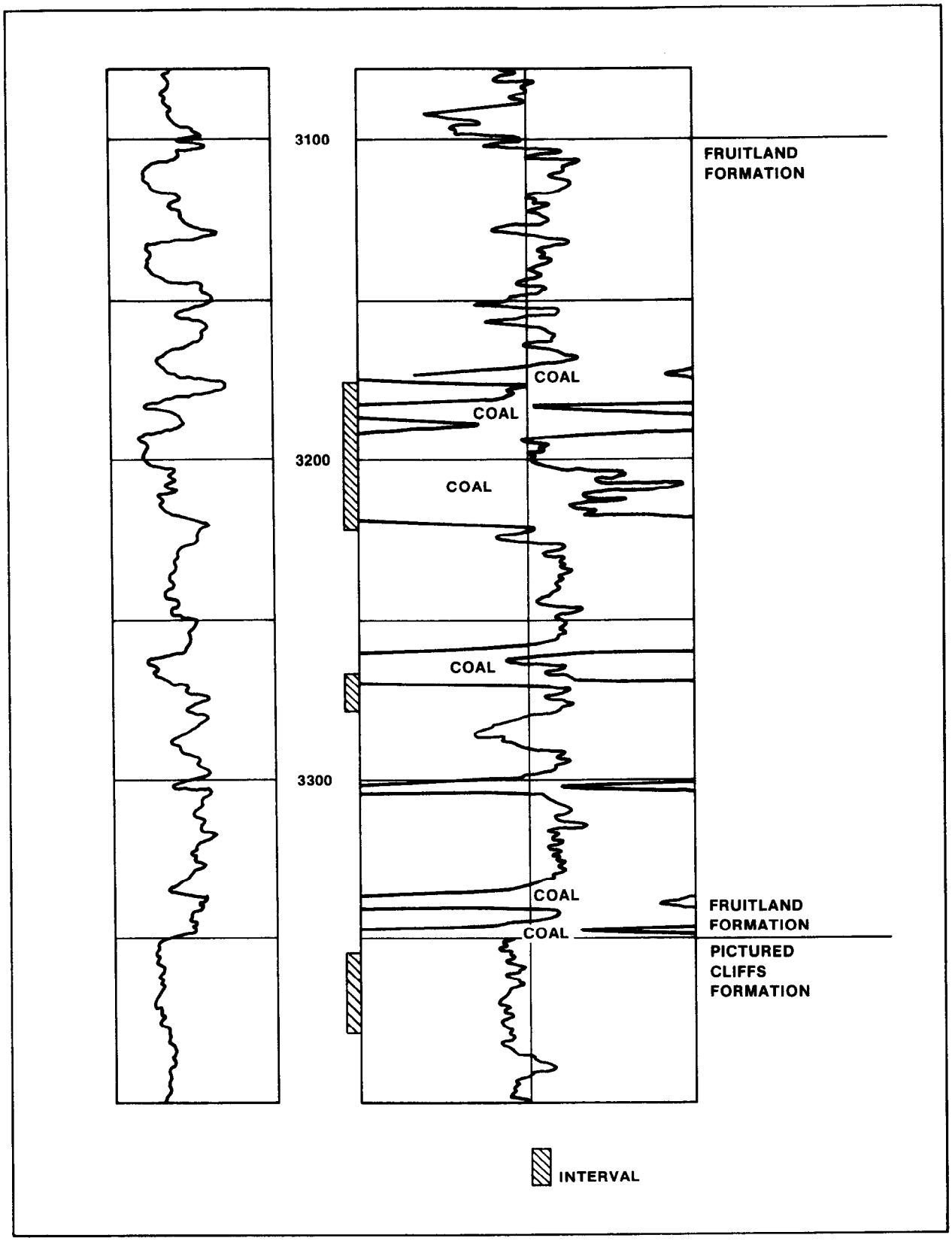

Figure 5. Compensated Formation Density Log-Palmer Oil and Gas State No. 2 Well, Section 2, T31N, R7W, San Juan County, New Mexico

daily production from the Pictured Cliffs Formation averaged 230 Mcf. The cumulative production as of April 1979 from the State No. 2 Well which includes the Fruitland Formation and Pictured Cliffs Formation production zones was 102 MMcf. The methane produced from this well is injected into a gas pipeline.

3.3.7 Dugan Production - ABO No. 1 Well

The ABO No. 1 Well was drilled in San Juan County, New Mexico during October 1975 to a TD of 1,175 feet. Production casing was set to 1,170 feet. Two intervals in the Pictured Cliffs Formation, one from 1,079 feet to 1,082 feet and the other from 1,084 feet to 1,088 feet, were perforated. These completion intervals are just below the contact with the overlying Fruitland Formation. The well was acidized with seven barrels of acid and 12 barrels of water with a pumping rate of 2-1/2 barrels per minute. After swabbing, the initial gas production was estimated to be 100 Mcfd. The electric log of the producing interval is shown in Figure 6. Monthly production from June 1976 through March 1980 is shown in Figure 7. Cumulative production from the ABO No. 1 Well through October 1980 is approximately 680,000 Mcf.

3.3.8 Dugan Production - Sterling No. 1-Y Well

The Sterling No. 1-Y Well was drilled in San Juan County, New Mexico during December 1975 to a TD of 850 feet. Production casing was set to 843 feet. Initially this well was perforated, fraced, and completed at the top of the Pictured Cliffs Formation between 693 and 702 feet (Figure 8). The well was then shut-in awaiting pipeline connection. In October to November 1978 the well was reentered and perforated in two additional intervals in the Fruitland Formation. The intervals were 615 to 620 feet and 624 to 630 feet (Figure 8). Initially the well kicked off making gassy water and gas, but this initial production died out. Subsequent swabbing and acidizing failed to stimulate production. The well was then again shut-in. In February 1979 the well was hooked up to a pipeline. Initial production proved very low and the well was shut in. The well was again put on production in January 1980. Production was better than previously recorded, but production records through March 1980 show a steady decline. Figure 9 shows

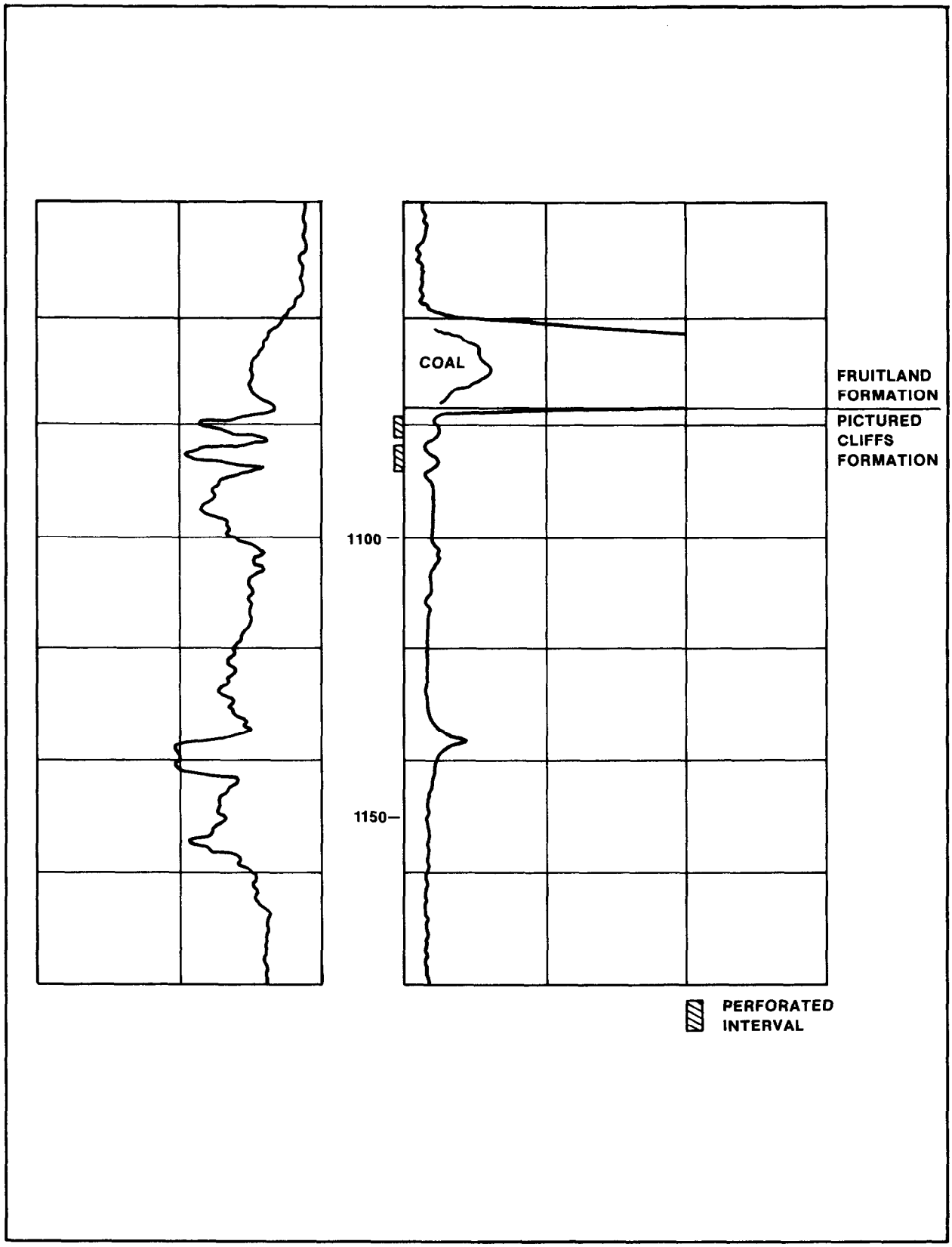

Figure 6. Electric Log Showing Producing Interval for Dugan Production ABO No. 1 Well, Section 28, T26N, R12W, San Juan County, New Mexico

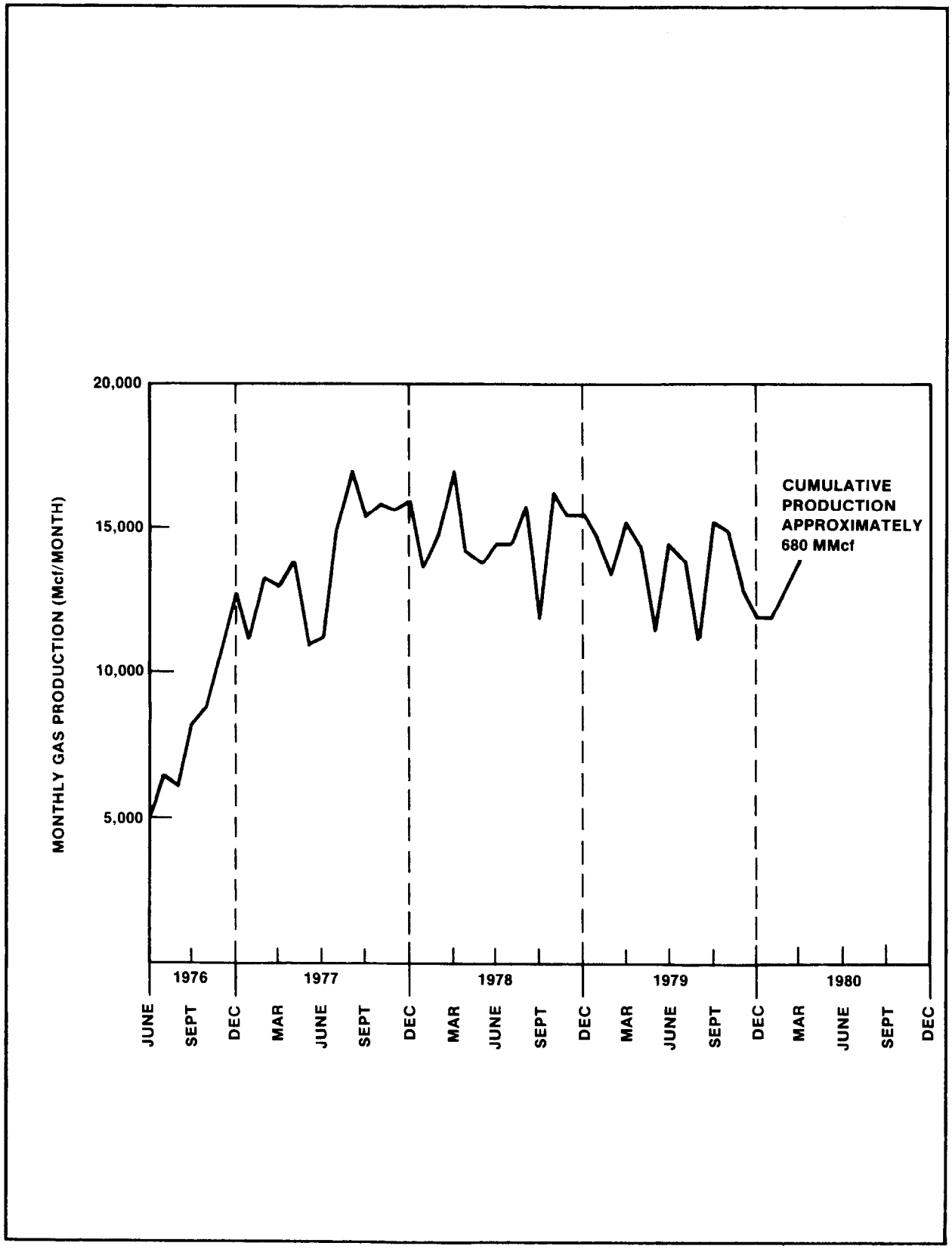

Figure 7. Monthly Gas Production, Dugan Production ABO No. 1 Well, San Juan County, New Mexico

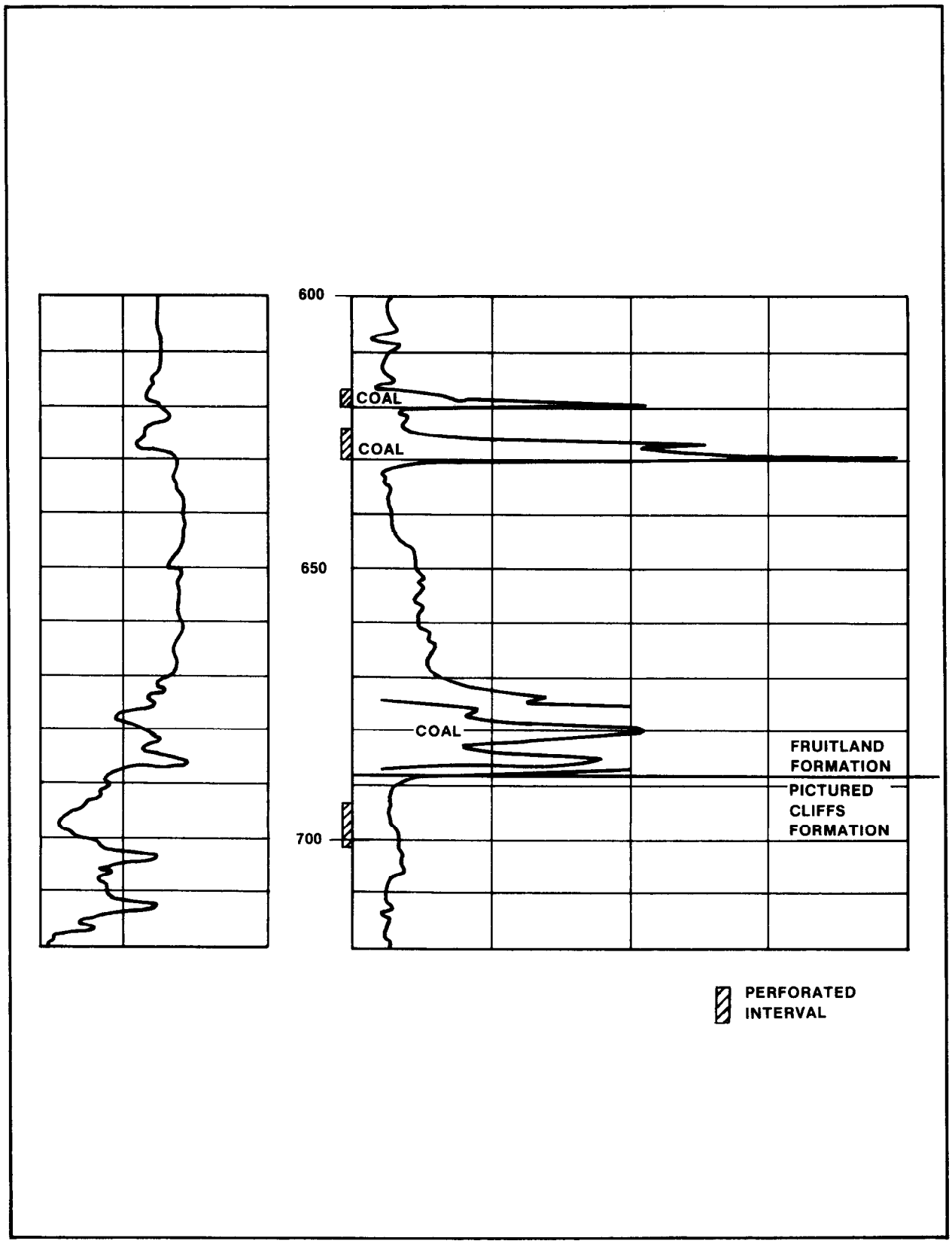

Figure 8. Electric Log Showing Producing Interval for Dugan Production Sterling No. 1-Y Well, San Juan County, New Mexico

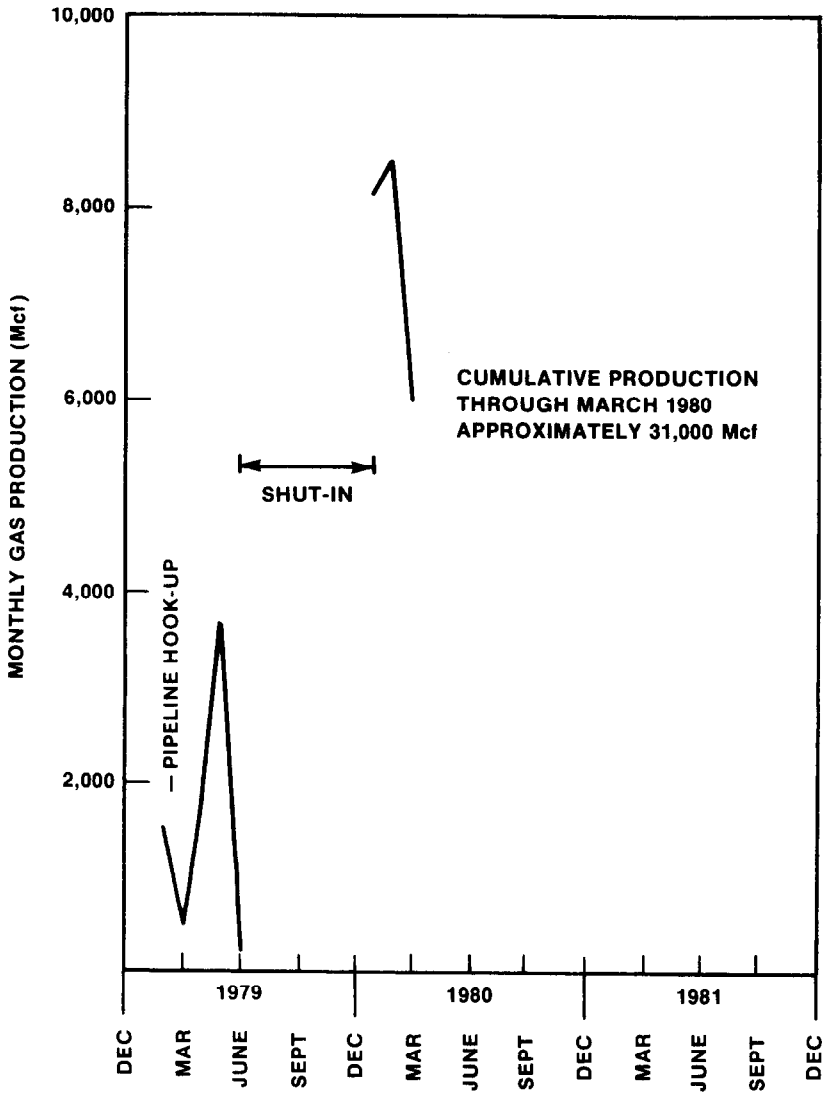

Figure 9. Monthly Gas Production, Dugan Production Sterling No. 1-Y Well, San Juan County, New Mexico

the periods of production and approximately monthly production through March 1980. Estimated cumulative production from this well through March 1980 is 31 MMcf.

3.3.9 Dugan Production - Knauff No. 1 Well

The Knauff No. 1 Well was drilled in San Juan County, New Mexico. Plug-back depth was 1,560 feet. In February 1976 the interval between 1,515 feet and 1,521 feet was perforated and fraced. This completion interval is a Fruitland Formation coalbed approximately six feet in thickness. Figure 10 is a section of the Induction Electric Log for this well showing the completion interval. Initial production following the frac treatment was estimated to be 100 Mcfd. Total production from April 1976 through October 1980 is approximately 190 MMcf. This well has shown a negative decline since initial production. Figure 11 shows the monthly gas production for this well from April 1976 through March 1980.

3.3.10 Dugan Production - Clay No. 1 Well

The Clay No. 1 Well located in San Juan County, New Mexico, was drilled in April 1976 to a TD of 1,350 feet. The contact between the Fruitland Formation and the underlying Pictured Cliffs Formation in this well is at a depth of approximately 1,230 feet. This well was perforated at three intervals, two in the Fruitland Formation and one in the Pictured Cliffs Formation. The Pictured Cliffs was perforated immediately below the contact with the overlying Fruitland Formation in the interval between 1,234 feet to 1,242 feet. The two intervals perforated in the Fruitland Formation were from 1,176 to 1,180 feet and from 1,134 to 1,138 feet. Figure 12 is a section of the Induction-Electric Log for this well showing the three perforation intervals.

Subsequent to perforating the three intervals outlined above, the well was fraced. Two operations were required due to a sandout during the initial attempt. After well cleanup operations following the second frac, the well was estimated to be making about 150 Mcfd. After obtaining this flow estimate the well was shut in until pipeline hook-up. Cumulative production through October 1980 for this well is estimated to be approximately 490 MMcf. Figure 13 shows monthly gas production for this well from January 1977 through March 1980.

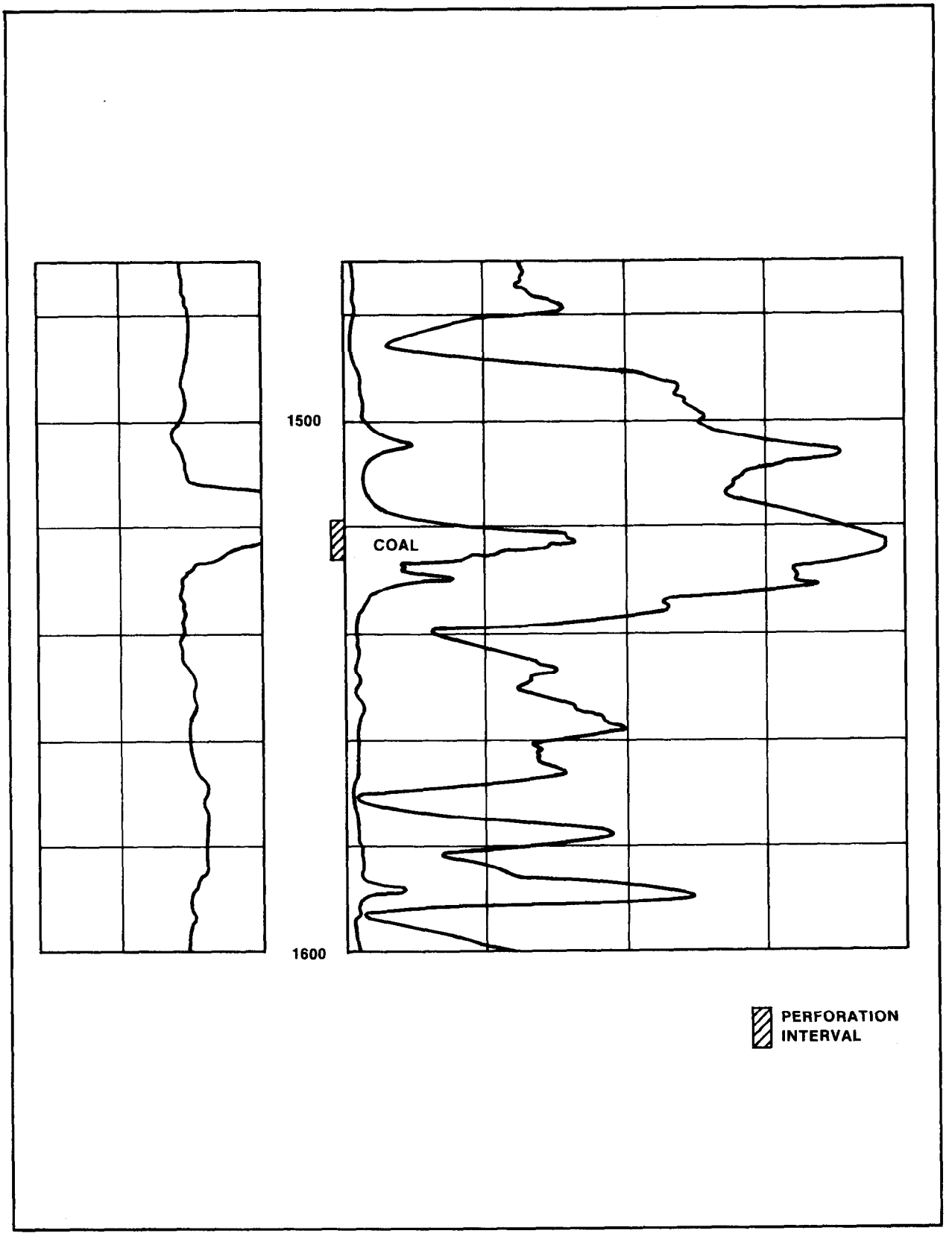

Figure 10. Induction-Electric Log Showing Production Interval, Fruitland Formation, Dugan Production Knauff No. 1 Well, San Juan County, New Mexico

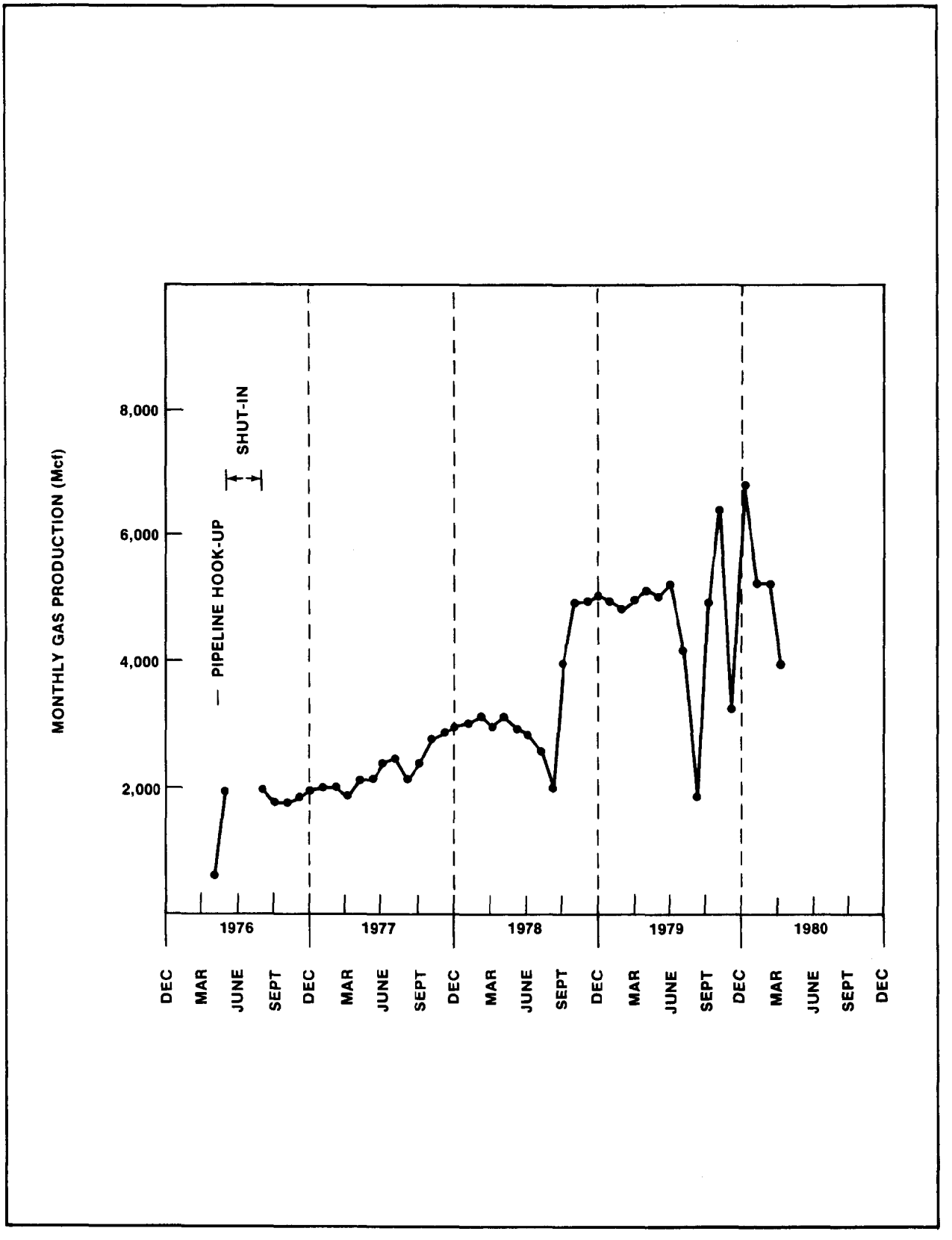

Figure 11. Monthly Gas Production, Dugan Production Knauff No. 1 Well, San Juan County, New Mexico

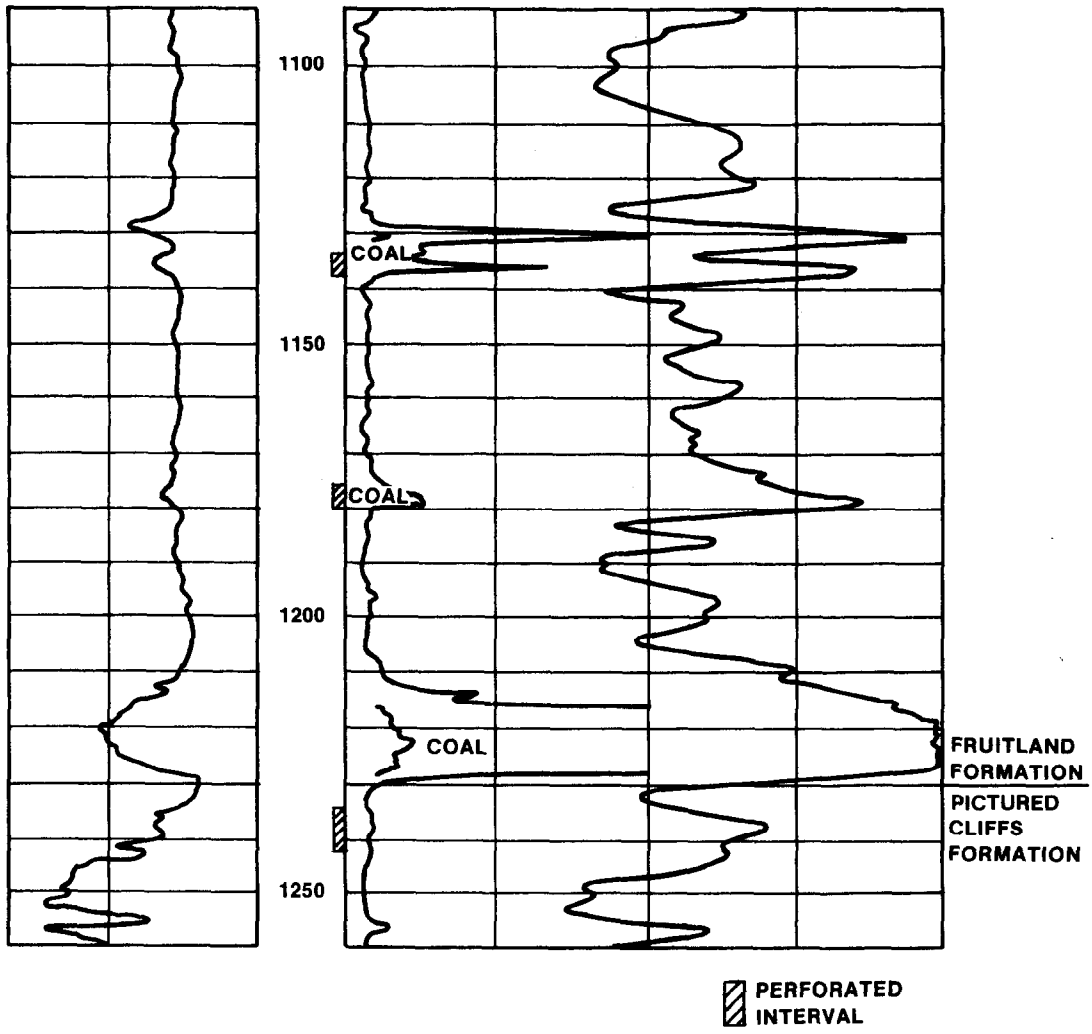

Figure 12. Induction-Electric Log Showing Production Intervals in the Dugan Production Clay No. 1 Well, San Juan County, New Mexico

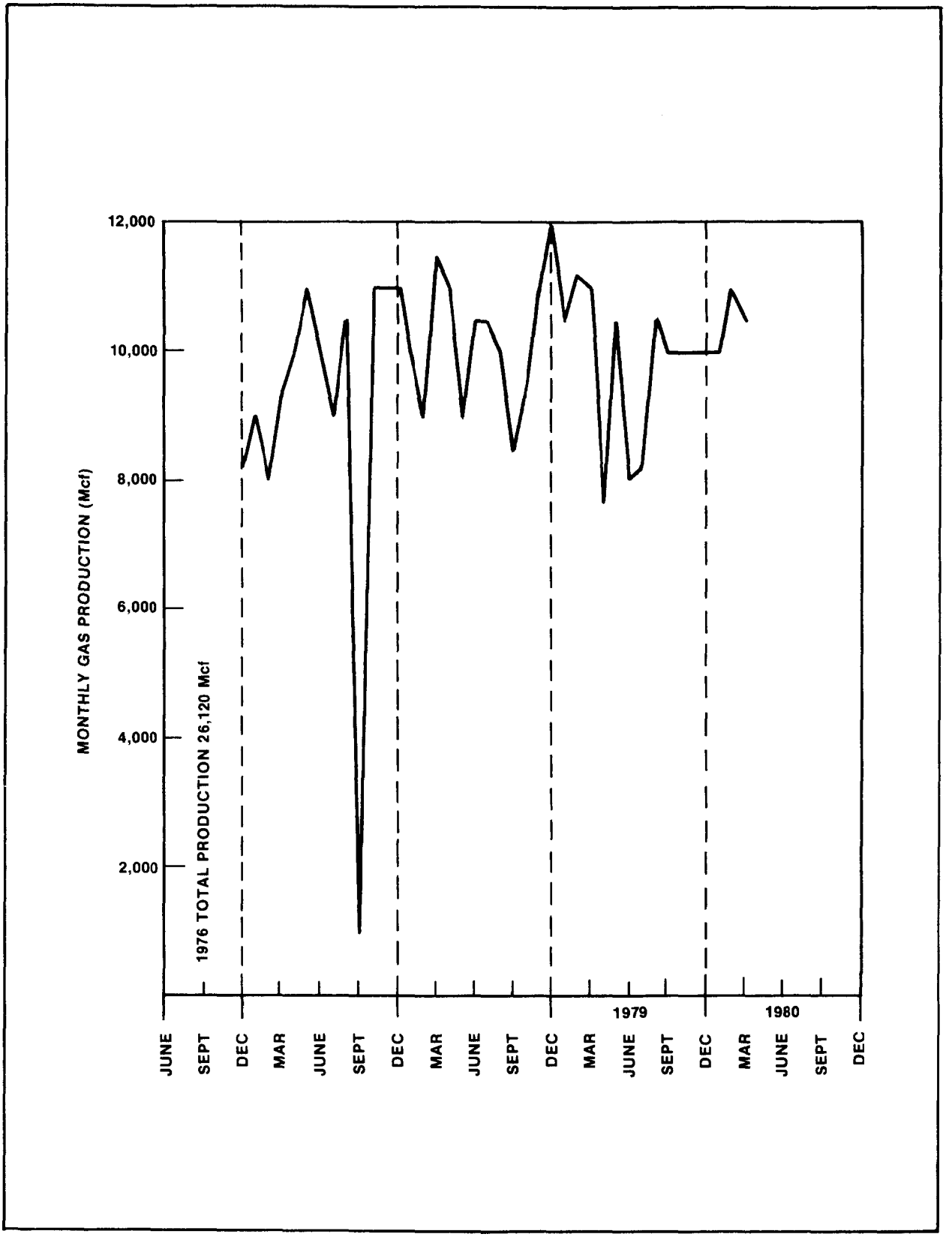

Figure 13. Monthly Gas Production, Dugan Production Clay No. 1 Well, San Juan County, New Mexico

3.3.11 Exxon Vega Unit No. 2

The Vega Unit No. 2 located in Mesa County, Colorado was started in April 1978. The well was drilled to a TD of 8,894 feet and plugged back to 8,140 feet. The final TD was in the Mesa Verde Formation which cover the interval from 5,338 feet to 8,490 feet in that well. Four zones were perforated and stimulated in the Mesaverde Formation. The perforations were located in the following intervals: 7,847 feet to 7,851 feet; 7,863 feet to 7,879 feet; 7,985 feet to 8,007 feet; and 8,046 feet to 8,052 feet. The lithologic logs for the well show coals in the zones perforated. An initial 24 hour testing of the well indicated a production of 440 Mcfd gas and 109 BBL/day water.

3.4 DRY GAS PRODUCTION FROM COAL-BEARING FORMATIONS

Very large quantities of methane are produced as a by-product of the coalification process. Though some part of this methane is retained in the coal through adsorption, a large proportion of it has been lost. It is possible that a part of this lost methane could be contained in various lithologic units overlying and underlying coalbeds.

Several basins in the western United States contain numerous gas fields which produce dry gas, that is, natural gas produced without appreciable liquid hydrocarbons, from coal-bearing formations. It is conceivable that this dry gas produced from coal-bearing formations is methane from coalbeds. To test this hypothesis, detailed review of existing geophysical logs, drilling records, completion and production records, and gas analyses from wells producing dry gas from coal-bearing formations is required. This type of detailed review will effectively supplement direct sampling and testing of coalbeds in these fields. The following sections on the San Juan Basin and the Greater Green River Coal Region are the initial step in this process for these two areas.

3.4.1 San Juan Basin, Colorado/New Mexico

Detailed review of the Four Corners Geological Society's publication, Oil and Gas Fields of the Four Corners Area, 1978, shows significant dry gas production from the coal-bearing Upper Cretaceous Fruitland Formation. Dry gas production from this formation is found virtually throughout the

San Juan Basin. Comparison of the limited well data available in this publication with appropriate coal sections from USGS Professional Paper 676, Geology and Fuel Resources of the Fruitland and Kirtland Shale of the San Juan, New Mexico and Colorado (Fassett and Hinds, 1971), indicates a strong correlation between gas producing intervals and coal seams. Of additional interest is the widespread trend of Pictured Cliffs completions just below the contact with the overlying Fruitland Formation. This contact is generally placed at the top of a massive sandstone directly below the lowermost coal of the Fruitland. The large number of Pictured Cliffs completions in the vicinity of this contact suggests that the gas production may be related to the overlying Fruitland Formation coals. Table 1 identifies gas fields with dry gas production from the coal-bearing Fruitland Formation and from the uppermost part of the Pictured Cliffs Formation. Figure 14 shows the township and range lines in the San Juan Basin to aid in locating the gas fields detailed in Table 1. These areas will be reviewed in as much detail as possible as part of future updates to the San Juan Basin Report.

3.4.2 Greater Green River Coal Region, Colorado/Wyoming

Detailed review of the Wyoming Geological Association's publication, Oil and Gas Fields of the Greater Green River Coal Region, 1979, shows significant dry gas production from coal-bearing Upper Cretaceous and Tertiary formations in several different areas of the region. Tertiary coal-bearing units which produce dry gas include the Wasatch and Fort Union Formations in the southern Washakie Basin/Cherokee Ridge Arch area and the Evanston (Almy) Formation in the LaBarge Platform area in the northwestern portion of the Green River Basin. Upper Cretaceous coal-bearing units which produce dry gas include the Lance Formation and the Mesaverde Group in the Rock Spring Uplift, Great Divide Basin, Washakie Basin, and Cherokee Ridge Arch areas and the Frontier Formation in the LaBarge Platform and Moxa Arch areas in the western part of the Green River Basin. Figure 15 shows these structural sub units of the Greater Green River Coal Region. Table 2 summarizes the areas of dry gas production from Tertiary coal-bearing units. Table 3 summarizes the areas of dry gas production from Upper Cretaceous coal-bearing units. These areas will be reviewed in more detail as part of future updates to the Greater Green River Coal Region Basin Report.

Table 1. Gas Fields in the San Juan Basin, Colorado/New Mexico, Which Produce Dry Gas from the Coal-Bearing Fruitland Formation and the Upper Part of the Pictured Cliffs Formation

Field	Location	
Blanco Pictured Cliffs	T28-32N	R7-12W
Los Pinos Fruitland, North	T32N	R7-8W
Mt. Nebo Fruitland	T32N	R10W
Aztec Pictured Cliffs	T28-31N	R9-12W
Los Pinos Fruitland, South	T31N	R7W
Conner Fruitland	T30N	R14W
Fulcher-Kutz Pictured Cliffs	T27-30N	R9-13W
Flora Vista Fruitland	T30N	R12W
Aztec Fruitland, North	T30N	R10-11W
Blanco Pictured Cliffs, East	T29-30N	R4W
Aztec Fruitland	T29-30N	R10-11W
Blanco Fruitland	T29-30N	R8-9W
La Jara Fruitland	T30N	R5-6W
Harper Hill Fruitland/Pictured Cliffs	T29N	R14W
Kutz Pictured Cliffs, West	T26-29N	R10-13W
Kutz Fruitland, West	T29N	R12-13W
Pinon Fruitland, North	T29N	R12W
Choza Mesa Pictured Cliffs	T28-29N	R3-4W
Ojo Fruitland/Pictured Cliffs	T28N	R15W
Pinon Fruitland	T28N	R11W
Kutz Fruitland	T28N	R10-11W
WAW Fruitland/Pictured Cliffs	T26-27N	R13W
Gallegos Fruitland, South	T26-27N	R11-12N
Gallegos Fruitland	T27N	R11W
Nipp Pictured Cliffs	T25-26N	R12W
Huerfano Pictured Cliffs	T25-26N	R9-10W
Potwin Pictured Cliffs	T24N	R8W
Twin Mounds Pictured Cliffs	T30N	R14W
Ignacio Blanco Fruitland/Pictured Cliffs (Colorado)	T32-34N	R6-11W

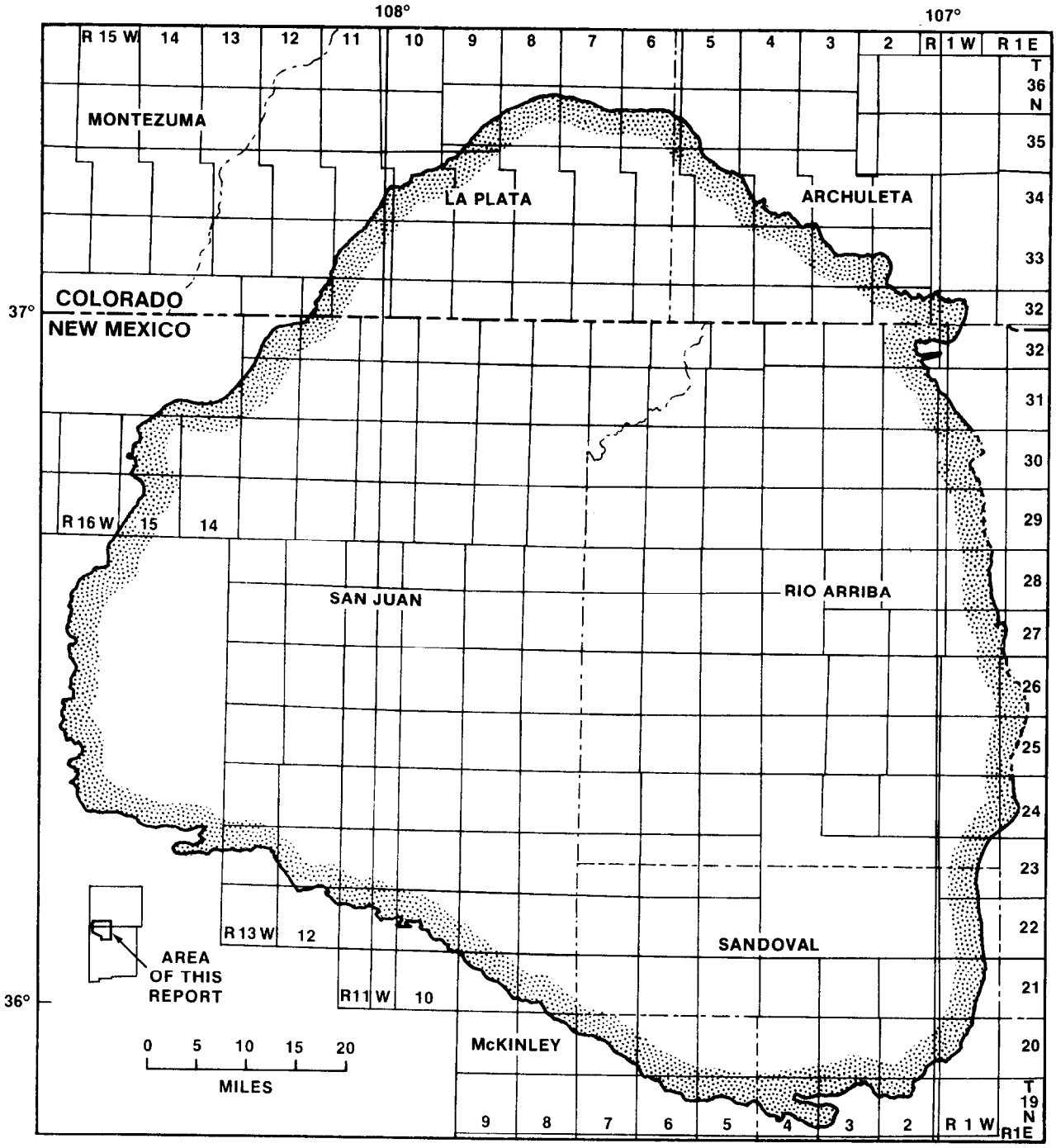

Figure 14. San Juan Basin, New Mexico and Colorado, Showing Township and Range Lines

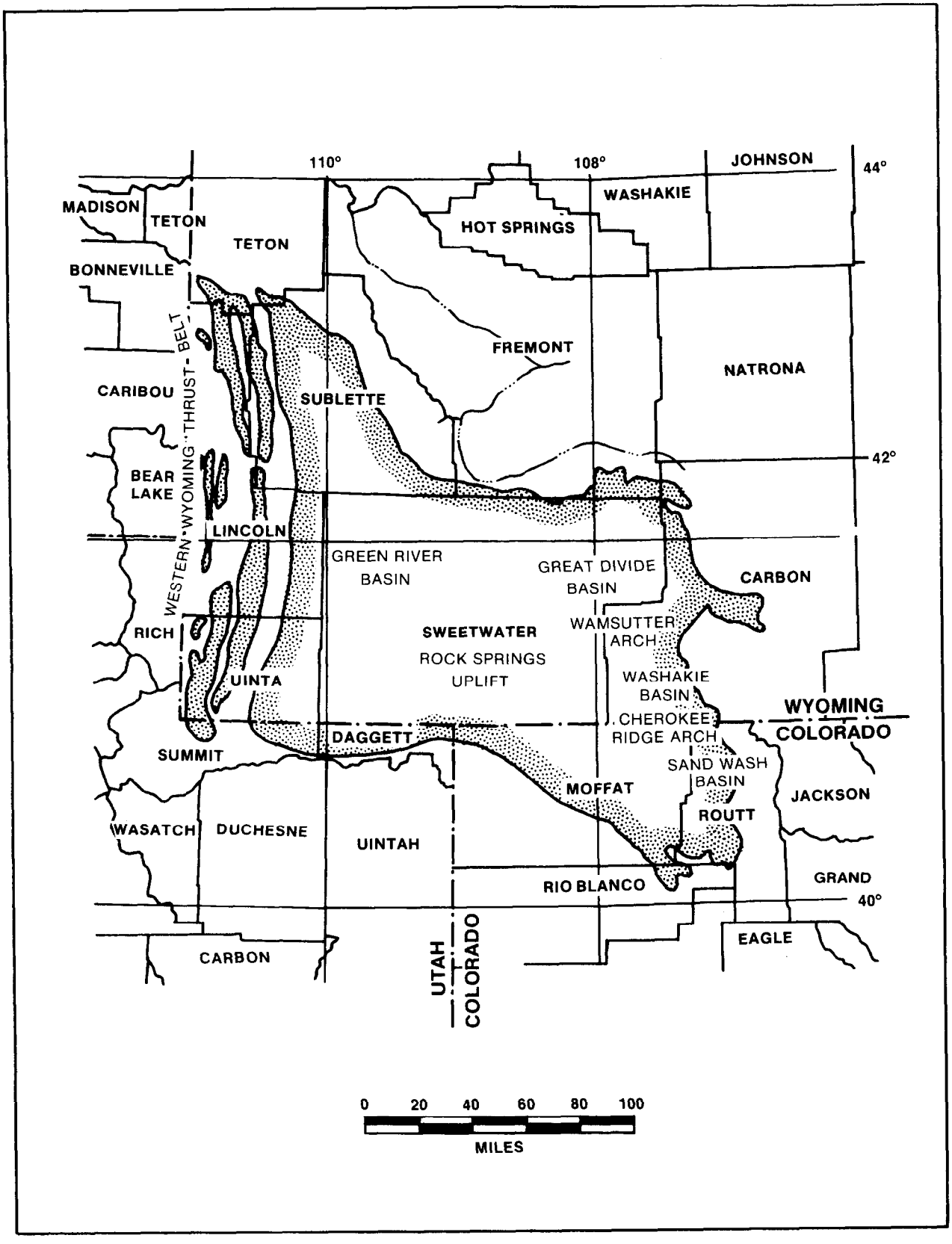

Figure 15. Structural Sub-units in the Greater Green River Coal Region

Table 2. Gas Fields in the Greater Green River Coal Region, Colorado/Wyoming, Which Produce Dry Gas from Tertiary Coal-Bearing Units

Field	Location	
Hiawatha, East	T12N	R99-100W
Kinney	T13N	R99-100W
Baggs South/Pole Gulch	T12N	R92-93W
Little Snake	T12N	R94-95W
Smith Ranch	T12N	R93W
State Line	T12N	R93-95W
Westside Canal	T12N	R91-92W
Chimney Butte	T28N	R112-113W
Goat Hill	T31N	R113W
Craven Creek	T24N	R114W

Table 3. Gas Fields in the Greater Green River Coal Region, Colorado/Wyoming Which Produce Dry Gas from Upper Cretaceous Coal-Bearing Units

Field	Location	
Westside Canal	T12N	R91-92W
Savery	T13N	R89W
Robbers Gulch	T14N	R91-92W
Haystack	T14N	R96W
Deep Gulch	T16N	R91W
Barrel Springs	T16N	R93W
Deep Creek	T16N	R90W
Salazar	T16N	R95W
Bitter Creek	T16-17N	R99W
Higgins	T17N	R98-99W
Sand Butte	T17N	R99W
Creston III Unit	T17-18N	R91-92W
Wild Rose	T17-19N	R93-95W
Delaney Rim Unit	T17-18N	R97-98W
Stage Stop	T18N	R99W
Tierney, North	T19-20N	R94W
Ten Mile Draw	T21N	R99W
Roser	T21N	R100W
Red Desert	T22N	R96W
Chimney Butte	T28N	R112-113W
Dry Piney	T27-28N	R114W
LaBarge East	T26-27N	R12W
Fontenelle II	T25-26N	R112N
Fabian Ditch	T20N	R112W
Clay Basin	T3N	R23-24E